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N502 N552 N564 N567 N569 N577 N58X N58Y N586
N587 N613 N625 N648 N649 N650 N658 N661 N670
N671 N677 N708 N709 N759 N76X

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(54) Abstract Title
Coatings

(57) Coatings 1 and 2 on a glass substrate 3 are formed by laying down layers of different thermosetting materials one upon the other in powder form on surface 4. The powder of transparent coating 1 has a higher-cure rate than that of colour coating 2 so that when heat is applied, coating 2 remains in the melt condition while the coating hardens, to bond with and enable rolling out onto coating 1, as well as bonding with a backing 5. Alternatively, materials of different cure-rates are used for bonding substrates together by bringing the two materials together while one is partly-cured and the other in the melt condition. The materials may be thermosetting materials deposited in powder form on the respective substrates.

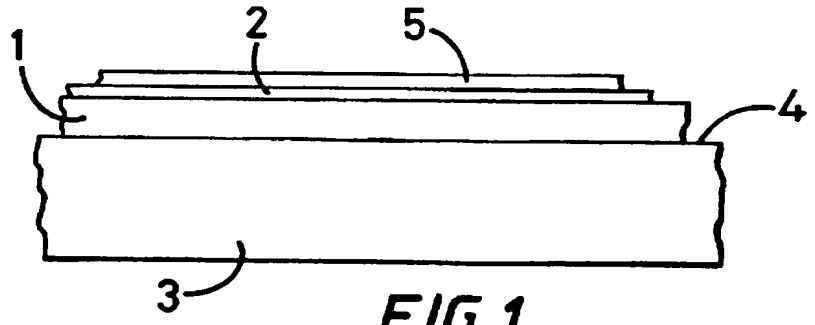

FIG. 1

GB 2 342 600 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

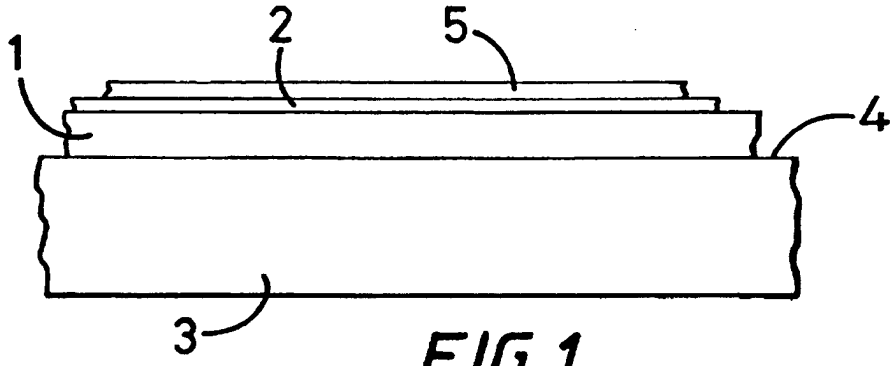

FIG. 1

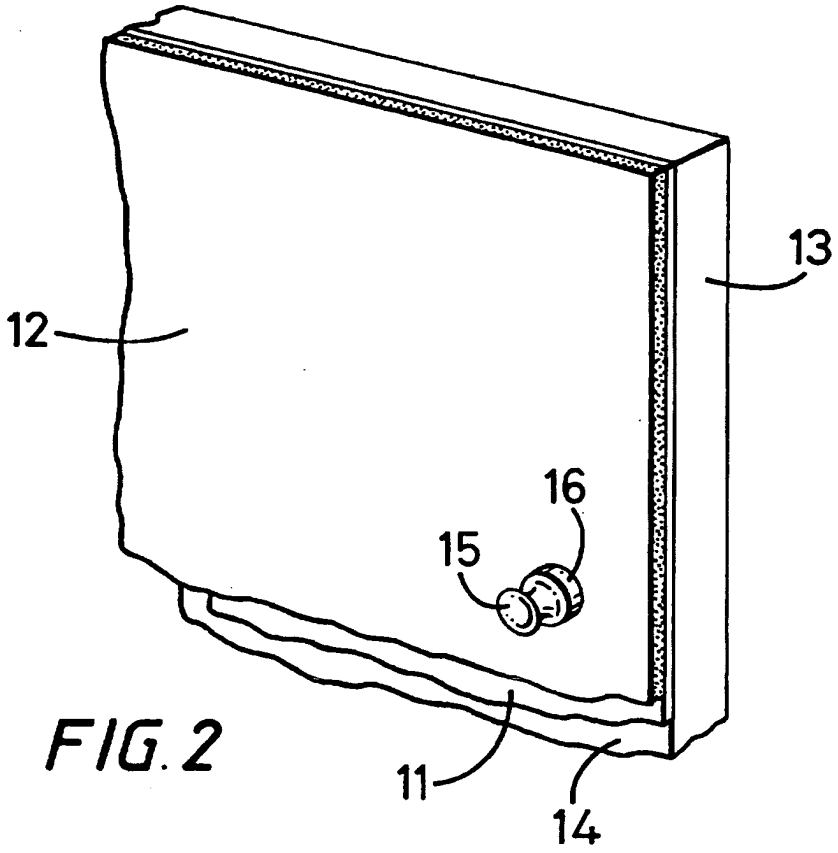

FIG. 2

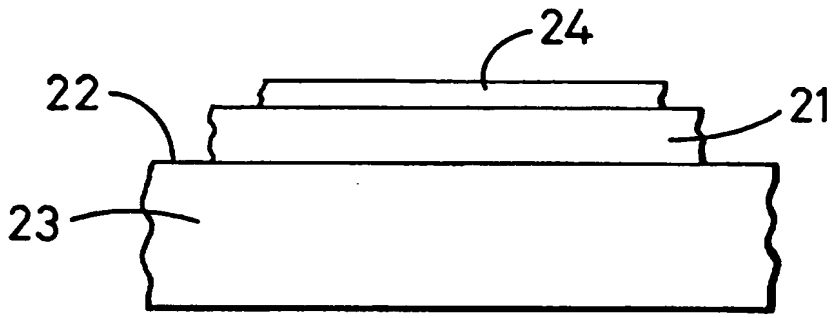

FIG. 3

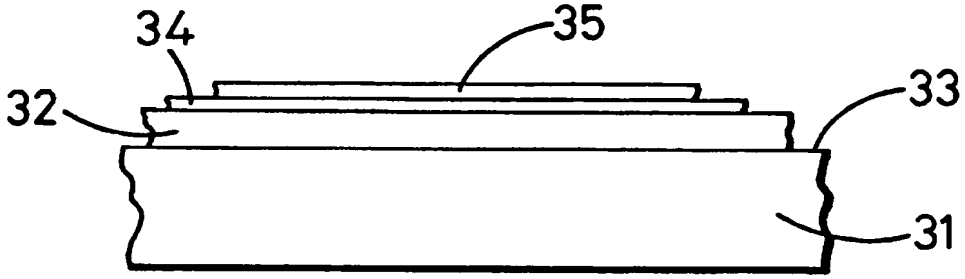

FIG. 4

Coatings

This invention relates to coatings.

It is known from GB-A-2207089 that powder coatings may be used for bonding two surfaces together by exploiting the melt phase to wet out the surfaces prior to effecting full cure to establish the bond. In normal circumstances, especially when the bond is required between sheets or other large-area surfaces, it is found necessary to employ nip rolling or other pressure-applying means (mechanical or vacuum) to enable a good laminate to be produced. Application of pressure, however, tends to press out the melted powder, and this can be of significant disadvantage where the powder is to provide a coloured or opaque coating to a glass or other transparent or translucent substrate. The applied pressure may result in thinning or pressing out of the melt such that on curing there is no solidity and uniformity of coating-colour or -opacity and the backing to the coating shows through. It is one of the objects of the present invention to provide a method of bonding by which such problems can be avoided.

According to one aspect of the present invention there is provided a method of coating wherein different thermosetting materials are laid down in powder form one upon the other on a substrate, and heat is applied to melt and fuse the powders into respective coatings bonded together on the substrate.

The powders may have different rates of cure from one another, and in these circumstances, the higher cure-rate powder may be laid down as a first layer on the substrate, and the lower cure-rate powder may be laid down as a second layer on the first layer. The lower and higher cure-rate materials may be, for example, epoxy,

polyester, or acrylic materials. Powder coatings can be produced with a variety of cure-rate windows so as to give markedly different rates of cure. The powders are commonly characterised in this regard as 'high-bake' ('low cure-rate') or 'low-bake' ('high cure-rate'); the terms 'high-bake' and 'low cure-rate' distinguish from the terms 'low-bake' and 'high cure-rate' in that a 'high-bake' or 'low cure-rate' material takes longer to cure at any given temperature than a 'low-bake' or 'high cure-rate' material.

With the method of the invention it is readily possible to obtain a good laminate without the disadvantage of thinning or pressing out of the melt, and in particular to avoid show-through where colour or opacity is required with a transparent or translucent substrate. In the latter respect, and using materials of different cure-rates, the higher cure-rate material may provide a coating with colour or opacity on a transparent or translucent substrate and the lower cure-rate material may be applied to it while the higher cure-rate material is in its initial un-cured state or at least still not fully cured. When this latter material hardens to form a solid and uniform coating, the lower cure-rate material is still in a state to wet the higher cure-rate coating and the backing surface that is pressed onto it, until curing is complete. Even if the pressure applied to the backing to complete the laminate during curing of the lower cure-rate material, presses out that material to be very thin, the already-cured solid-colour or opaque coating visible through the substrate, remains unaffected.

According to another aspect of the present invention there is provided a method of bonding two surfaces together wherein the bond is effected using two bonding materials that have different cure-rates, the material of

lower cure-rate being applied to the material of higher cure-rate while this latter material is in the uncured state, prior to curing of both.

Methods of coating and bonding in accordance with the present invention will now be described, by way of example, with reference to the accompanying drawings. in which:

Figure 1 is illustrative of a laminate manufactured according to the method of the invention;

Figure 2 is illustrative of a laminate door-panel manufactured according to the method of the invention; and

Figures 3 and 4 are illustrative of the manufacture of further laminate panels, according to the invention.

Referring to Figure 1, two coats 1 and 2 of thermally-curing powder are applied one upon the other on a substrate 3. The base coat 1 is a low-bake powder (high cure-rate) and is applied to a surface 4 of the substrate 3. While the powder of the coat 1 is still uncured, the second coat 2, which is of a higher-bake cure-window (lower cure-rate), is deposited on it. Heat is then applied to melt both coats 1 and 2, the base coat 1 softening and then hardening first to effect a good bond with the surface 4. The second coat 2 remains wet to ensure good bonding between the cured coat 1 and a backing 5 that is pressed, for example by a nip roller (not shown), onto the coating 2. The applied pressure may press out the melted powder of the coat 2 until curing of the coat 2 is complete, but the first-hardened coat 1 remains substantially unaffected and continuous.

Heat is not applied to melt or cure the low- and high-bake powders until both coats 1 and 2 have been laid down in powder form one upon the other. However, it is preferable to warm the substrate 3 so as to keep the surface 4 free from condensation, but this is not generally intended to affect the condition of the powder deposited on it to any significant extent. The fact that one layer of powder is deposited on the other before heat is applied for melting to take place, is believed to improve the bond between the two coats 1 and 2 because of inevitable intermingling of the powders to some degree, at the interface of the two layers.

Thermosetting powders having different cure-rates may be used according to the invention for the straightforward bonding of one item to another, for example as illustrated in Figure 2.

Referring to Figure 2, two 'paint' coats 11 and 12 (corresponding to coats 1 and 2 respectively) which are applied to a door panel 13 to protect and give colour to its surface 14, also serve to bond an article such as, in this instance, a door handle 15, to the panel 13. The panel is manufactured by first depositing on the surface 14 (electrostatically or by gravity feed) a layer of low-bake powder for the coat 11, and then a layer of high-bake powder on the first powder layer, for the coat 12. Heat is then applied to melt both powder layers and cure the first layer into the coat 11. While the second powder layer is still in the melt phase after the first layer has cured into (or is in an advanced stage towards) the hardened coat 11, the base 16 of the door handle 15 is pressed hard onto the melt and held there until the second layer has cured into the hardened coat 12.

The second powder layer acts to wet out the bond between the coat 11 and the base 16 and ensure a firm bond. It

may provide a clear, protective covering to the coat 11 which will normally be coloured, and may have afford a gloss or satin finish to the door panel 13.

Resistance to runs and surface imperfections of coatings may be avoided using the method of the invention. The application of first surface colouring, 'painting' is assisted in this process by the ability to apply different colours or thicker coatings in a one-oven line. Conventionally each coat is cured before the application of a second coat, whereas with the technique of the present invention two or more coats of differing or similar colour and/or clear (possibly gloss) coat may be applied before any curing takes place. The coats are applied as successive powder layers from, for example, separate guns, without any steps being taken to cure one layer before application of the other; once the layers of powder have been deposited, heat is applied to cure them all together in the one step. Each successive powder layer laid down has a slower cure-rate than the one preceding it and this ensures that during the resultant progressive cure, a finish without runs or orange peel effect is achieved. If the final coat is clear gloss, a particularly high quality finish is obtained.

The invention may be readily applied to the formation of solid, coloured or clear laminates. In particular, a base material may be coated by the adhesion of another similar or differing flexible material. For example, a laminate may be brought together by tightly winding a foil or plastics element upon a pipe or tube, or if a planar sheet is involved by using a nip roller or press during the cure phase. Low-bake powder is applied to the base component and then re-coated with a higher-bake powder before curing is commenced. When the cure is for example, about 70% complete, the low-bake powder is hard,

but the high-bake is still soft to allow foil(s) or plastics element(s) to be applied with good adhesion.

Where powder coatings are deposited on glass or metal substrates it is usually necessary to promote the bond with the glass or metal surface by use of an adhesion promoter such as a silane. Rather than depositing a silane film on the substrate as is conventional, it is possible however, to include the silane in the coating powder. More particularly, the silane can be involved in the initial mix used for manufacture of the powder, and it has been found advantageous to include acid as well where glass is involved. In the latter respect, the acid is included with the object of providing appropriate pH-modification of the glass surface, to enable optimum action of the silane.

Two powder-coated panels formed using coating powders that include a silane and an acid as referred to above from manufacture, will now be described with reference to Figures 3 and 4.

Referring to Figure 3, a thermosetting epoxy-based powder is in this case deposited electrostatically as a layer 21 on a surface 22 of a substrate 23 of toughened glass. The powder includes, from manufacture, silane and acid components as referred to above, as well as pigmentation. Heat to melt and cure the powder of layer 21 is applied only after a layer 24 of polyethylene powder has been deposited electrostatically on the layer 21.

The applied heat causes both powder layers 21 and 24 to melt. The acid in the melted layer 21 is activated to modify the pH at the surface 22 and initiate the action of the silane to provide the conditions for good adhesion with the surface 22. The melting of the polyethylene layer 24 on the other hand cause a degree of intermixing

with the melted epoxy layer 21 at their interface, so that on hardening of the layer 24 and curing of the layer 21 there is cohesion between them in a good physical bond.

Referring to Figure 4, the panel in this case involves a substrate 31 of annealed glass and a transparent polyester-based powder deposited electrostatically as a layer 32 on a surface 33 of the substrate 31. The powder of layer 32 includes, from manufacture, silane and acid components as referred to above, and a layer 34 of another polyester powder not including such components, is deposited electrostatically on the layer 32. The powder of layer 34 includes pigmentation.

Heat is applied to melt and cure the powders of both layers 32 and 34. During the melt phase of the powder of layer 32, its acid component is activated to modify the pH at the surface 33 and initiate the action of the silane to provide the conditions for good adhesion with that surface. Furthermore, there is cross-linking at the interface between the two layers 32 and 34 so that when the powders cure there is a strong chemical bond between the resultant coatings and between them and the substrate 31.

It is desirable that the layer 32 cures faster than the layer 34 so that while it is gelling a nip roller can be used to press down and smooth out the layer 34 for even cover of the coating of layer 32. Furthermore, a water-protective foil 35 is laid down in contact with the layer 34 while still in the melt phase so as to be bonded firmly to it on cure of this layer.

A laminate comprising two layers of glass or plastics bonded together to show the same or similar colours viewed from either side, can be manufactured by the

application of a fast-curing powder containing pigmentation to one glass or plastics layer and a slow-curing powder either on top of that or to the other glass or plastics layer; the slow-cure powder provides a clear coat. Both components are then heated to where the low-bake powder becomes substantially hard but the high-bake coat is still wet, the two components being nip rolled or pressed together as curing of both coats is completed and the resultant laminate formed.

If different colours are to show from the two sides of the laminate, low-bake powder containing a respective pigment is deposited on each glass or plastics component, and high-bake powder on top of one (or possibly both) of the low-bake layers. During curing, the low-bake primary coats on both components cure to hard but are not fully cross-linked (for example about 70% cured) while the high-bake powder is still soft. In this condition the two components are nipped together and then fully cured; the applied pressure enables gas to be pressed from the laminate. The cohering high-bake powder is preferably, though not necessarily, such as to provide a clear coat.

Although the substrate and other components used in the methods as described above are generally non-porous, the invention is applicable where the components are of a porous nature. In this respect, a primary coat of low-bake powder may be applied to a porous (or other) substrate and after over-coating with a high-bake powder, cured to about 70%. A second component is coated with a high-bake powder and while this coating and the high-bake coating of the first component remain soft, the two components are pressed together for completion of the curing process. The advantage of this method is that the press stage is undertaken when the primary film is continuous and substantially hard so as to ensure that

there is no bleed through the porous material from the adhesive layer, during the pressing phase.

The use of powders with differing cure-rates optimises cross polymerisation of the two coatings; the dual-cure process enables processing to take place in a perfect gas-free and clean environment right through to full cure.

The two coatings may also be two coats of catalyst or ultra-violet curing adhesives with different cure windows. When catalyst adhesives (for example those sold under the trade marks ARALDITE and ARALDITE RAPID) or resins are used, the two cure-rates may be accommodated chemically, allowing for more control of the adhesive layer than hitherto. Conventionally, one-coat application of an adhesive is usually advised. The two components have to be brought together at an early cure time to ensure that the adhesives wet out both surfaces, and then held to full cure, often leading to the bond line being pressed out.

With the method of the present invention, a coat of adhesive is applied to both components, one a fast-cure adhesive and the other a slower-cure adhesive that is formulated to be hard, but not fully cross-linked, when the one is still soft. The faster-cure adhesive delivers a substantially viscose coating that resists the pressure used to bring the surfaces together by nip roller, or press or clamp. The slower-cure adhesive wets out the second surface and offers an optimum bond.

In a process known as the 'Unilam' process, a resin adhesive (such as acrylic, catalyst activated resin) is used for bonding two sheets of glass together. The two glass sheets are held upright spaced apart from one another by a gasket while the resin is poured into the

Claims:

1. A method of coating wherein different thermosetting materials are laid down in powder form one upon the other on a substrate, and heat is applied to melt and fuse the powders into respective coatings bonded together on the substrate.

2. A method according to Claim 1 wherein the powders have different rates of cure from one another.

3. A method according to Claim 2 wherein the higher cure-rate powder is laid down as a first layer on the substrate, and the lower cure-rate powder is laid down as a second layer on the first layer.

4. A method according to Claim 2 or Claim 3 wherein while the second layer is still in the melt phase and the first layer is substantially cured, an item to be bonded to the substrate is brought into contact with the second layer and held there until the second layer cures.

5. A method according to any one of Claims 1 to 4 wherein one or both powders include pigmentation.

6. A method according to any one of Claims 1 to 5 wherein one of the powders when fused is transparent.

7. A method of bonding two surfaces together wherein the bond is effected using two bonding materials that have different cure-rates, the material of lower cure-rate being applied to the material of higher cure-rate while this latter material is in the uncured state, prior to curing of both.

8. A method according to Claim 7 wherein the materials are thermosetting materials and are deposited in powder form on respective substrates that are to be bonded together, heat is applied to both powders to melt them and to cure partly the material of higher cure-rate such as to bond it to its substrate, and this partly-cured material is then brought into contact with the melted material of low cure-rate so that upon curing of both materials a bond is established between them.

9. A method according to Claim 8 wherein one or both powders include pigmentation.

10. A method of manufacturing a laminate substantially as hereinbefore described with reference to any one of Figures 1 to 4 of the accompanying drawings.

Application No: GB 9923907.1 **Examiner:** Richard Kennell
Claims searched: 1-6/10 **Date of search:** 3 February 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): B2E (EFD, EN, EQ, EM), B5N

Int Cl (Ed.7): -

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X, P	GB 2328628 A	(NIPPON PAINT), 3 March 1999, whole document	1-3/5
X	GB 2257929 A	(TUDOR-HART), whole document	1,5,6
X	EP 0525867 A	(AKZO), see particularly page 4 lines 25-33	1,5,6
X	EP 0137663 A	(SHAW INDUSTRIES), whole document	1
X	WO 95/19399 A	(ARSONSISI), whole document	1,5,6
X	US 4104416 A	(PARTHASARATHY), see claims 17/20	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.